DOCUMENT RESUME

ED 103 651 CE 003 255

TITLE	How Over 600 Firms Manage the Maintenance Force: Summary Report of a Second Survey of Maintenance Administrative Ratios.
INSTITUTION	Ramond (Albert) and Associates, Inc., Chicago, Ill. Research Planning Div.
PUB DATE	73
NOTE	23p.; For the 1969 survey see CE 003 254
EDRS PRICE	MF-$0.76 HC-$1.58 PLUS POSTAGE
DESCRIPTORS	*Administration; *Maintenance; Manufacturing Industry; National Surveys; *Organization; Personnel Data; Ratios (Mathematics); *Relationship; Statistical Data; *Statistical Surveys; Tables (Data)

ABSTRACT

A survey questionnaire, directed to determining the management of the maintenance force, was mailed to 4,104 nation-wide companies. Of the 669 responses, 623 were sufficiently complete to use in the study. The survey data are presented in the form of charts and tables, grouping the companies by the type of manufacturing reported. Each data table is prefaced by a discussion of the factors relating to the ratio and is followed by a brief analysis of findings. The participating companies are profiled. Data are then presented on the number of total plant employees per maintenance hourly employee. The number of maintenance hourly employees are presented per maintenance supervisor, per maintenance planner, per special technician, per industrial engineer, per stores employee, and per maintenance staff employee. Data are also presented on: the type of maintenance work planned, maintenance hours planned, extent of outside contracting of maintenance work, the length of training programs, the extent of use of special technicians and industrial engineers, how maintenance work is measured, the value of the facility and equipment maintained, the use of electronic data processing in maintenance, and the use of financial incentives for maintenance personnel. Brief conclusions are drawn from the data. (AG)

ED 103 651

HOW OVER 600 FIRMS MANAGE THE MAINTENANCE FORCE

Summary Report of a Second Survey of Maintenance Administrative Ratios

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RESEARCH PLANNING DIVISION

1973

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Preface

Albert Ramond and Associates, endeavoring to portray changing profiles as they occur in maintenance management, presents the latest report of the Maintenance Management Survey. As practiced in the previous report, data for each company reported herein has been maintained on a confidential basis so that the information for any specific company cannot be identified.

This revised report based on a survey conducted during 1972 is expanded in terms of scope and participation of 121 more companies throughout the country over the 502 companies in the first report, made in 1969.

METHOD

Survey questionnaires were mailed to 4,104 nation-wide companies and 669 replies were received. These returns were reviewed for completeness and 623 companies, representing 942,089 employees, were finally selected. The screened returns were then coded and forwarded to a service bureau which tabulated the data provided in the report.

The ratios in this report are average ratios weighted by the number of firms reporting.

FORMAT

The participating companies have been grouped by the type of manufacturing reported. For convenience, data has been provided separately for ten industries representing the largest number of returns. Each data table is prefaced by a discussion of the factors relating to the ratio and followed by a brief analysis of findings. Participating companies are encouraged to interpret the data in terms of their particular company and industry.

OVERVIEW

It is the intent of this survey to provide to operating management "guidelines" for maintenance operations based on current industry practices. Judgments regarding the efficiency or effectiveness of maintenance activities among the industries cannot be made from the data presented, and it should be remembered that the data in this report identifies present operating conditions and not the *attainable* levels of maintenance performance.

To provide a basic orientation to this report, and a comparison to the previous survey, the following are the average characteristics of the typical company participating in both surveys:

Average Participating Company

	1972	1969	
Total Plant Employees:	1,512	1,093	
Maintenance Craft and Trades Hourly:	6%	6%	of Total Plant Employees
Maintenance Staff Employees:	8%	7%	of Maintenance Hourly Employees
Storekeeping Personnel:	3%	3%	of Maintenance Hourly Employees
Maintenance Supervision:	1%	(N.A.)	of Total Maintenance Hourly Employees
Special Maintenance Technicians:	2%	3%	of Total Maintenance Hourly Employees
Maintenance Planners:	2%	4%	of Maintenance Hourly Employees
Industrial Engineers in Maintenance:	1%	1%	I.E.'s to Maintenance Hourly Employees
Type of Measurement:	Estimates	Estimates	
Maintenance Hours Planned:	45%		Not Reported in 1969 Report
Maintenance Incentives	6%	(N.A.)	% of Responding Companies

Comparisons between the 1969 and 1972 survey are shown on the following data tabulations where it is deemed practical and/or commented on in the analysis. However, since the disparity between the surveys may be attributed to any number and type of variables, complete explanations and conclusions will be difficult to make.

Albert Ramond and Associates, Inc.
Survey of Maintenance Administrative Ratios

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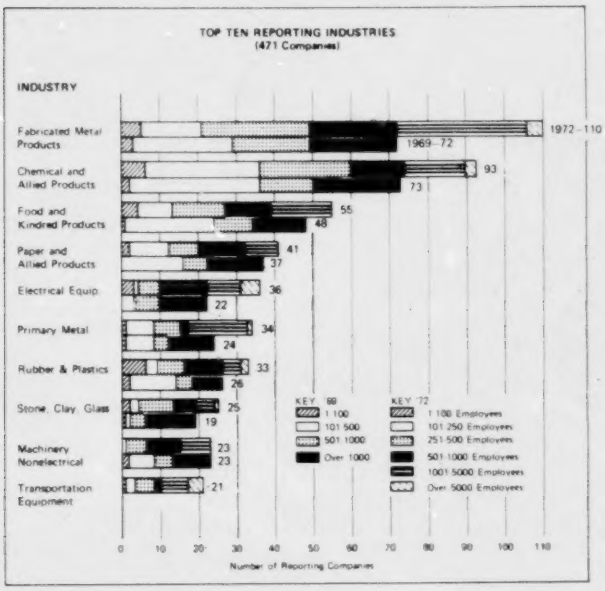
I. Profile of Reporting Companies

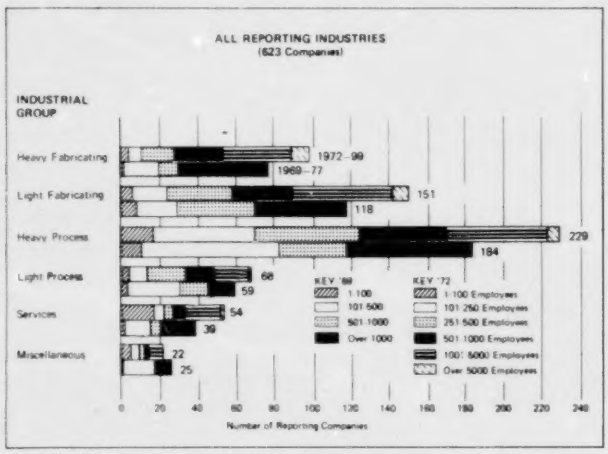
SCOPE

The participating companies have been grouped according to type of manufacturing reported. The industry groupings shown in the following graphs have been used consistently in the data presented in this report. When the data is provided for a small number of companies, the information may be of interest, but should not be used as typical of company practice in that industry or industrial group.

DATA

Distribution of Reporting Companies by Industry and Number of Total Plant Employees





Composition of Industrial Groups by Industry and Number of Companies Reporting

Heavy Fabricating (99) – Electrical Equipment (36); Aerospace (4); Machinery Nonelectrical (23); Transportation Equipment (21); Ordnance (5); Lumber-Wood (10).

Light Fabricating (151) – Fabricated Metal Products (110); Printing (14); Leather (3); Furniture (2); Electronics (7); Instruments-Cameras (12); Medical (3).

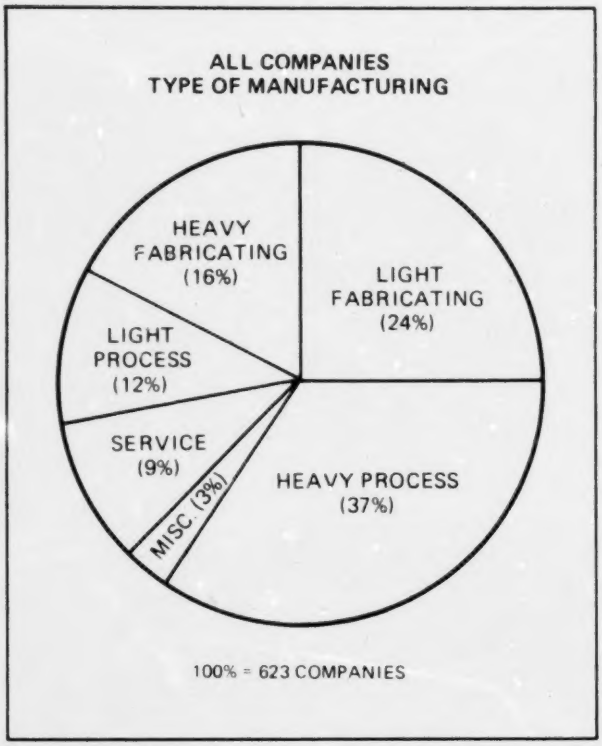
Heavy Process (229) – Chemicals (93); Paper (41); Rubber (33); Primary Metal (34); Stone, Clay, Glass (25); Petroleum (3).

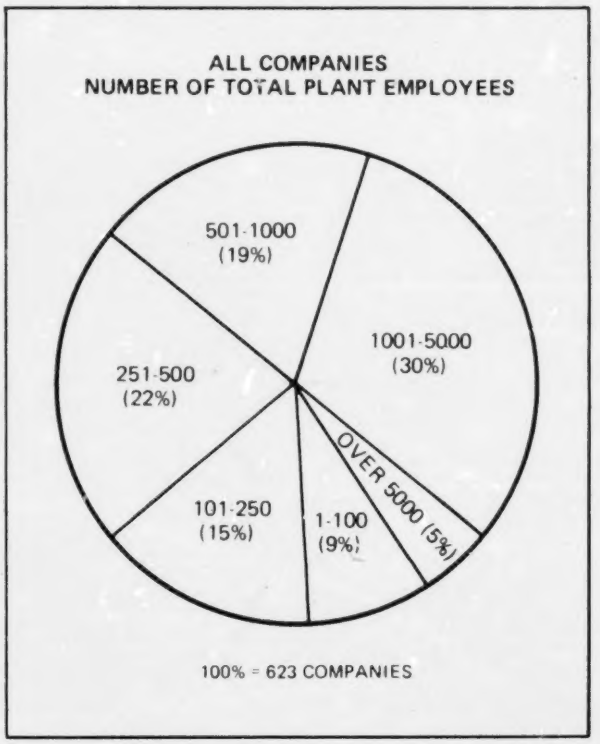
Light Process (68) – Foods (55); Textiles (9); Apparel (3); Tobacco (1).

Services (54) – Hospitals (16); Education (7); Government (9); Office Buildings (4); Research-Science (11); General Services (7).

Miscellaneous (22) – Industries were not identified.

Distribution of Reporting Companies by Type of Manufacturing and Number of Total Plant Employees





ANALYSIS

The ratios and other data contained in the balance of the report have been computed as weighted averages based on the number of firms reporting in either an industry or industrial group. An individual company should, therefore, consider its relative ranking in the industrial groups, regarding type of manufacturing and number of employees, prior to relating the guidelines to its maintenance operations. A company with under 100 total plant employees should, for example, consider the fact that 91% of the companies in our sample had over 100 employees. Practices may differ substantially by plant size even in the same industry.

Within the major industrial groups, a single industry may dominate the average ratio. In the Light Fabricating group, for example, the Fabricated Metal Products industry constitutes 73% of the total number of firms in the group. Maintenance practices in the Instruments-Cameras industry will have only one-ninth the weighting of Fabricated Metal Products in the group average.

Nine of the top ten reporting industries remained in this survey with the Transportation Equipment Products replacing the Electronics Products from 1969.

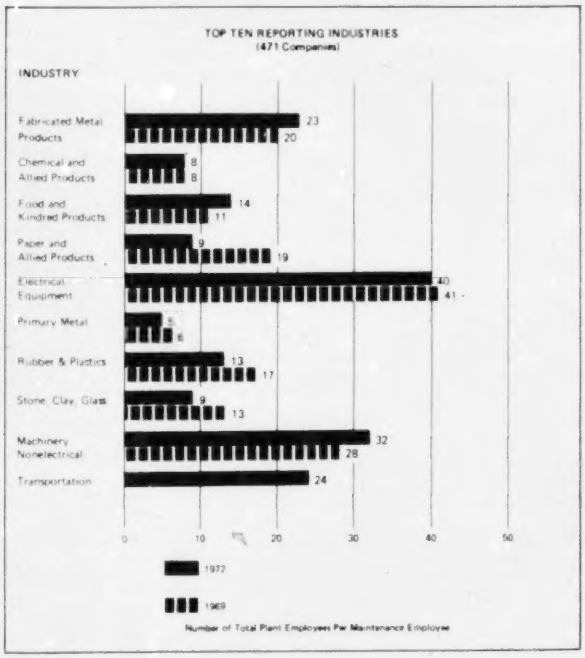
An attempt is made to more clearly indicate company sizes and impact within groupings by expanding the number of employee ranges from 4 in 1969 to 6 in the current report.

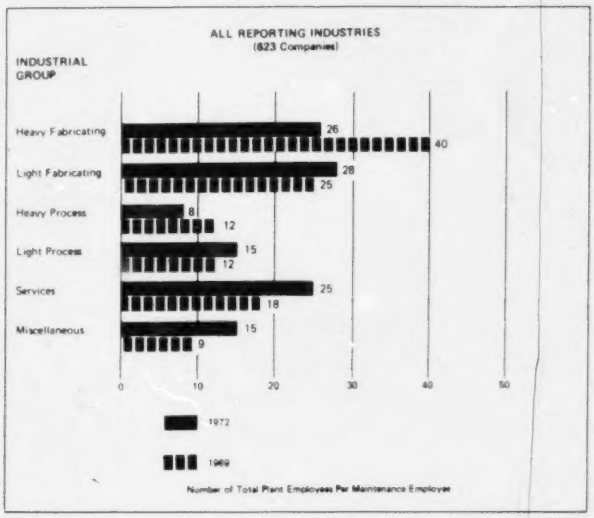
II. Maintenance Manpower Requirements

SCOPE

The size of the maintenance force in relation to total plant employment is determined by a large number of complex variables. Consideration must be given to factors such as the age and complexity of equipment in the plant, the economic importance of production downtime, quality requirements of the product produced, and management's policies regarding the level or quality of maintenance activity that is desired. The guidelines presented here should, therefore, be interpreted by an individual company in terms of its own particular situation. The following graphs present the average ratios, by industry, of the number of Total Plant Employees per Maintenance Hourly Employee. The Total Plant Employee category includes management, supervisory and technical employees with the maintenance hourly classification including all craft and trades personnel but excluding janitorial and utilities employees.

DATA





ANALYSIS

The average ratio of Total Plant Employees to Maintenance Hourly Employees has decreased slightly (17:1 to 16:1) from 1969. However, when expressed as a percentage of Maintenance Hourly Personnel to Total Plant Personnel, the figure of 6% remains unchanged from 1969. Essentially the same overall significant variations and ranges of ratios that existed in 1969 are unchanged. It should be noted that in 1972 the Service and Miscellaneous groups indicate a significant decrease while the Heavy Fabricating group has increased the number of maintenance personnel as related to total employment.

Apparently the wide variations in the ratio are directly related to the degree of mechanization present in each industry even with the larger survey response. Where large amounts of capital equipment have been substituted for direct labor and/or has increased their productivity, more maintenance men are required to service the equipment. Conversely, where industries can increase productivity with additional manual labor such as the Services, the maintenance force can be held relatively constant. Controlling the maintenance force to perform economically, as well as efficiently, to avoid excessive downtime costs, as well as unnecessary maintenance labor costs, is important. The Paper and Allied Products industry has the largest increase in the number of maintenance employees per total plant employee, going from nineteen plant employees per maintenance employee in 1969 to nine plant employees per maintenance employee in 1972.

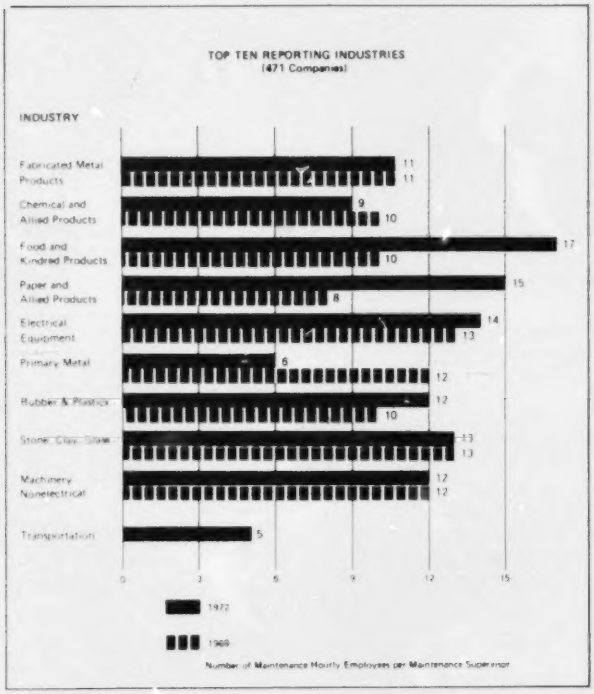
III. Supervising the Maintenance Force

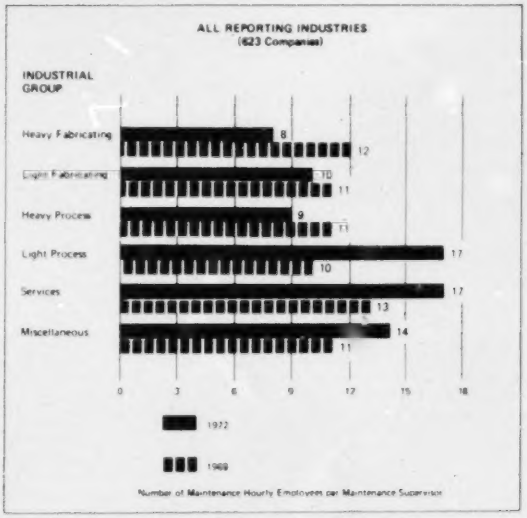
SCOPE

The number of maintenance employees a supervisor can effectively control is to a large degree determined by the nature of the maintenance department organization. In companies where supervisors are required to plan and schedule the work, oversee craft training efforts and monitor direct labor performance, the ratio of hourly employees per supervisor will be lower than the ratio in companies where management has established maintenance staff functions to provide these necessary services. The skill level of the maintenance hourly force and the physical plant area must also be considered when determining the proper hourly to supervisory ratio for an individual company.

The following graphs present the average ratios, by industry, of the number of hourly maintenance employees per supervisor. The maintenance hourly classification includes all craft and trades employees (excluding utilities and janitorial personnel). The supervisory category includes all foremen and first-line supervisors engaged in controlling the maintenance hourly force with the exception of working lead men or crew leaders.

DATA





ANALYSIS

The average ratio of maintenance hourly employees per supervisor decreased (11:1 to 10:1) from 1969 for all reporting industries. The Light Process group shows a substantial change (10:1 to 17:1) in its ratio for 1972 primarily due to the Food and Kindred Products industry. Paper and Allied Products has doubled their ratio (8:1 to 15:1) thus yielding the low ratio position to the Transportation, Chemicals and Primary Metal industries in 1972.

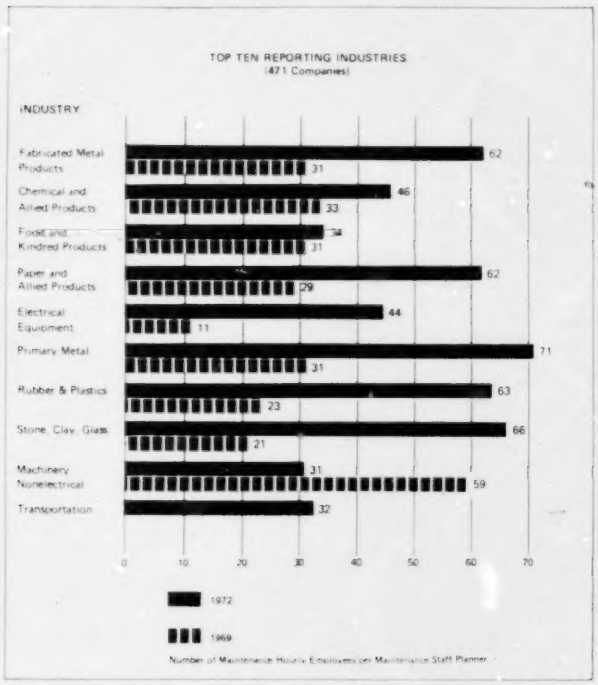
It should be noted that Heavy and Light Fabricating plus the Heavy Process industrial groups have reduced their ratio of maintenance employees per supervisor while the Light Process, Services and Miscellaneous groups have increased their ratios significantly. This current level of the latter three groups is approaching the hourly to supervisory ratio normally found in the production departments. The low ratio to maintenance supervision is generally explained as maintenance not functioning with the equivalent staff support usually provided in production areas, thus limiting the number of maintenance employees that can be effectively controlled.

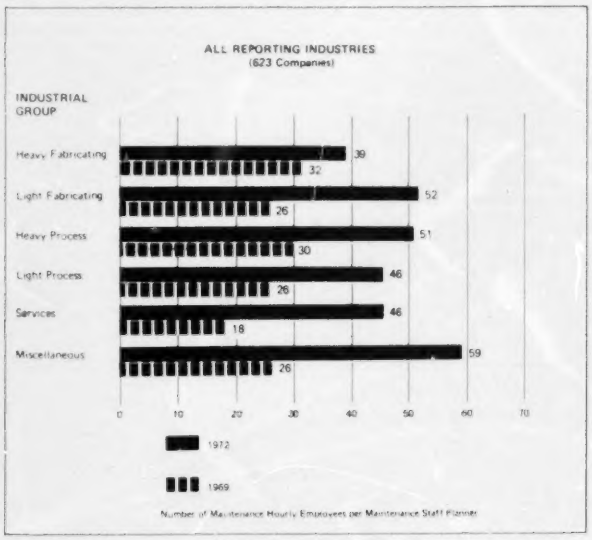
IV. Planning Maintenance Work

SCOPE

The following graphs present the average ratio of the number of maintenance hourly employees per maintenance staff planner. The maintenance staff planner classification includes all personnel in staff capacities who plan maintenance work excluding planning that is performed on a part-time basis by maintenance supervisors. The maintenance hourly classification includes all hourly craft and trades personnel (excluding utilities and janitorial employees).

DATA





ANALYSIS

There is a substantial increase from the 1969 survey in the ratio of maintenance employees to maintenance staff planners in all industrial groups and all except one industry in the top ten listing (Machinery, Nonelectrical). The overall average ratio for all reporting industries has increased from 28:1 to 45:1. The significance of this change may be attributable to veteran planning functions being capable of enlarging the scope of their activities to more maintenance work and personnel, or it may indicate a budgeting reduction in the planning force. Variations in the ratio among industries, although generally larger than in 1969, are associated with the different types of planning performed. Companies which perform only project, major overhauls, and/or long duration repair job planning will have a much higher ratio of hourly employees per planner than companies where detailed job planning is a standard practice.

It is noteworthy that the lowest industry ratio in 1972 is 31:1 as compared to 11:1 in 1969. Our experience has shown that a well-trained and organized planning function, given the proper tools and backing, will perform effectively and contribute to maintenance economic benefits significantly. In fact, some companies seeking maintenance cost reduction start with the creation of input controls, such as planning, prior to maintenance labor performance controls.

V. Type of Maintenance Work Planned

SCOPE

The survey has established four general classifications for planned maintenance work. They range in magnitude from full-scale project planning to repair jobs of under four hours duration. Full-scale project-type activities may involve major facilities additions or modifications. Major projects may be large-scale overhauls, repairs or rebuilds. Jobs of four hours or more are smaller scale repair work and jobs of under four hours duration may be minor repair activities.

DATA

INDUSTRY	Total Firms	No. of Firms Responding	% Response of Total	FULL SCALE PROJECT		MAJOR PROJECT		OVER FOUR HOURS		UNDER FOUR HOURS	
				% of Response	No. Firms	% of Response	No. Firms	% of Response	No. Firms	% of Response	No. Firms
Fabricated Metal Products	110	110	100	65	71	60	66	46	50	21	23
Chemical and Allied Products	93	81	87	90	73	80	65	78	63	26	21
Food and Kindred Products	55	52	95	83	43	79	41	73	38	15	8
Paper and Allied Products	41	38	93	89	34	87	33	66	25	29	11
Electrical Equipment	36	33	92	85	28	67	22	58	19	15	5
Primary Metal	34	32	94	78	25	81	26	59	19	34	11
Rubber and Plastics	33	32	97	81	26	66	21	63	20	38	12
Stone, Clay, Glass	25	21	84	95	20	86	18	52	11	14	3
Machinery, Nonelectrical	23	19	83	95	18	63	12	58	11	11	2
Transportation	21	20	95	85	17	90	18	65	13	30	6
Total – All Industries	471	438			355		322		269		102
Average – All Industries			93	81		74		61		23	
Ranking Position				1		2		3		4	

INDUSTRIAL GROUP	Total Firms	No. of Firms Responding	% Response of Total	FULL SCALE PROJECT		MAJOR PROJECT		OVER FOUR HOURS		UNDER FOUR HOURS	
				% of Response	No. Firms	% of Response	No. Firms	% of Response	No. Firms	% of Response	No. Firms
Heavy Fabricating	99	90	91	88	79	69	62	64	58	20	18
Light Fabricating	151	129	85	83	107	74	96	59	76	26	33
Heavy Process	229	207	90	87	181	80	166	68	140	28	58
Light Process	68	63	93	79	50	78	49	68	43	22	14
Services	54	50	93	80	40	62	31	74	37	36	18
Miscellaneous	22	22	100	68	15	68	15	73	16	27	6
Total – All Groups	623	561			472		419		370		147
Average – All Groups			90	84		75		66		26	
Ranking Position				1		2		3		4	

ANALYSIS

The type of maintenance work planned is a statistical presentation which is a new addition to our survey, so there is no prior year for consideration in making a comparative analysis.

It is of interest to note that two industry categories: Stone, etc., and Machinery had 95% response in the project planning area. This is indicative that these two contributors are planning the major portion of their large-scale maintenance activity. From experience it is known that large-scale projects are nearly always planned in these industries due to the fact that as larger amounts of capital are appropriated, higher ranking executives are intensely interested in the purposeful direction of activity, but the depth or level of detail to which the reported planning has been carried has not been discerned. At one end of the depth of planning scale there could be a division of the project into several major sections each of which contains a large number of activities. At the other end of the scale the project could be divided into many diversified activities with each activity being planned in detail.

It is also of interest to note that a much smaller percentage of response was received in the survey classification "planning work of under four hours' duration". In fact, it can be observed that on both display charts the percentages go from high response in project planning to low in the under four hours class. This is indicated in practically every case.

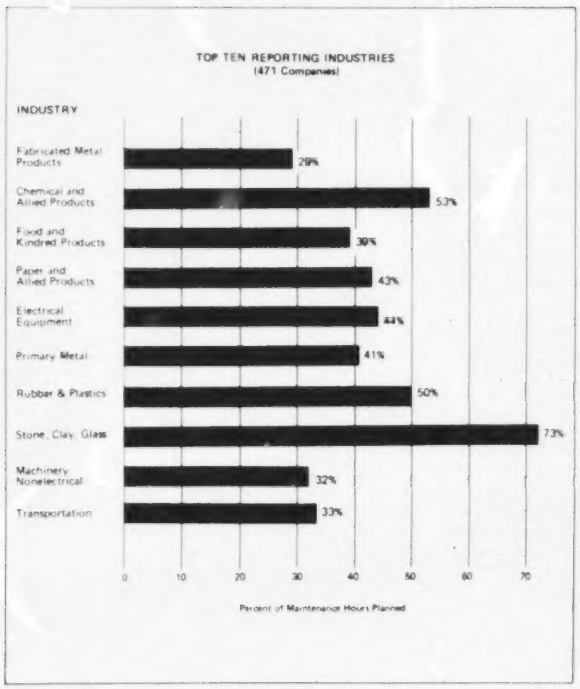
In some maintenance groups the shorter duration jobs are of lesser importance, constituting a small portion of the total hours expended. However, the total work order input should be examined to determine how concentrated and important the over four hours and under four hours classifications are to the total maintenance spectrum, prior to drawing any conclusions.

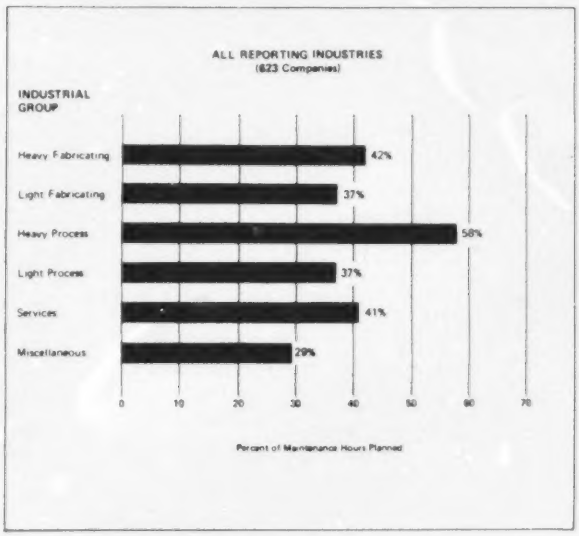
VI. Maintenance Hours Planned

SCOPE

The maintenance hours planned in total represent the hours being accrued in the four classifications as defined in Section V. They are project, major, over four hours' duration and under four hours' duration. The percentage appearing on the following bar graphs for each reporting industry is an expression of the segment of the total maintenance-hour spectrum which is presently being planned.

DATA





ANALYSIS

For all reporting industries, the overall percentage of maintenance hours being planned is 45%. With 45% as a median, the percentages range from a high of 58% in the Heavy Process industry to 29% in the Miscellaneous industries which are made up of a mixture of Light Fabricating and Light Processing.

It is logical to expect that the "capital intensive" industries of Heavy Processing and Heavy Fabricating would expend greater effort to plan and control their maintenance forces due to the loss-pyramiding effects of downtime in these production-oriented industries.

The other industries reporting are not lagging very far behind the leaders in percentage of total hours planned. While there is not the pyramiding effect of loss in these other groups as that experienced by "capital intensive" industries during breakdowns, there is certainly a considerable loss which cannot be ignored. Planning maintenance in these industries adds to profitability and may increase the Net Worth of Assets. Expensive machinery and equipment are protected and their value conserved through the implementation of planned inspection and preventive maintenance activities being systematically carried out.

VII. Outside Contracting of Maintenance Work

SCOPE

The charts following represent the percentage of outside contracting of maintenance work allowed, and the percentage of reporting firms that allow a particular percentage of outside contracting. There are two charts: Top Ten Reporting Industries and All Reporting Industries.

The charts have a number of percentage ranges for percentage values of contracted work to be placed within. There are slots for no outside contracting of maintenance work, up to 10%, 10-20%, 20-30%, 30-40%, 40-50% and over 50%. Within each of the slots the number of respondents experiencing that level of contracting is shown along with the percentage of the total respondents that number represents.

DATA

INDUSTRY	Total Firms	No. of Firms Responding	% OF OUTSIDE CONTRACTING OF MAINTENANCE WORK											
			NONE		Up to 10%		10%-20%		20%-30%		30%-40%		40%-50%		Over 50%	
			% of Response	No. Firms	% of Response	No. Firms	% of Response	No. Firms	% of Response	No. Firms	% of Response	No. Firms	% of Response	No. Firms	% of Response	No. Firms
Fabricated Metal Products	110	109	9	10	59	64	21	23	5	5	5	6	–	–	1	1
Chemical and Allied Products	93	91	9	8	54	49	25	23	7	6	–	–	5	5	–	–
Food and Kindred Products	55	54	9	5	55	30	28	15	4	2	4	2	–	–	–	–
Paper and Allied Products	41	41	17	7	76	31	7	3	–	–	–	–	–	–	–	–
Electrical Equipment	36	35	14	5	57	20	12	4	14	5	3	1	–	–	–	–
Primary Metal	34	33	18	6	52	17	24	8	6	2	–	–	–	–	–	–
Rubber and Plastics	33	32	3	1	50	16	28	9	16	5	3	1	–	–	–	–
Stone, Clay, Glass	25	25	8	2	80	20	12	3	–	–	–	–	–	–	–	–
Machinery Nonelectrical	23	23	17	4	57	13	13	3	9	2	4	1	–	–	–	–
Transportation	21	21	9	2	57	12	19	4	5	1	–	–	5	1	5	1
Total – All Industries	471	464		50		272		95		28		11		6		2
Average – All Industries			11		59.		20		6		2		1		1	
Ranking Position			3		1		2		4		5		6		6	

INDUSTRIAL GROUP	Total Firms	No. of Firms Responding	% OF OUTSIDE CONTRACTING OF MAINTENANCE WORK											
			NONE		Up to 10%		10%-20%		20%-30%		30%-40%		40%-50%		Over 50%	
			% of Response	No. Firms	% of Response	No. Firms	% of Response	No. Firms	% of Response	No. Firms	% of Response	No. Firms	% of Response	No. Firms	% of Response	No. Firms
Heavy Fabricating	99	98	14	14	58	57	14	14	9	9	2	2	1	1	1	1
Light Fabricating	151	150	10	15	54	82	20	30	9	13	5	7	—	—	2	3
Heavy Process	229	225	11	24	59	134	21	47	6	13	1	2	2	5	—	—
Light Process	68	67	10	7	55	37	25	17	3	2	5	3	—	—	2	1
Services	54	54	9	5	35	19	24	13	20	11	2	1	6	3	4	2
Miscellaneous	22	21	—	—	52	11	38	8	5	1	5	1	—	—	—	—
Total – All Groups	623	615		65		340		129		49		16		9		7
Average – All Groups			11		56		21		8		3		1		1	
Ranking Position			3		1		2		4		5		6		6	

ANALYSIS

From the charts it can be seen that the concentration of maximum contracted hours by all respondents would represent a percentage range of up to 10% of their total maintenance hours. Of course, some firms contract no maintenance work as one extreme, and a very few contract over 50%, as the other extreme.

There are several reasons for outside contracting of maintenance work. Among these are insufficient numbers of maintenance personnel, insufficient productivity of present employees, requirement of specialized skills not presently on the maintenance roster and others. In some cases specialized contractors, independent vendors and the like can actually accomplish certain specialized activities better and more economically than existing staff.

In some plants where Plant Engineering is a separate function from maintenance, outside contracting is accomplished by Engineering without the cognizance of maintenance. In all cases, where the organizations are separate, maintenance should have the opportunity of reviewing work to be placed outside prior to any contract being let.

It is a cardinal rule of Maintenance Management to fully evaluate any proposal for outside contracting to ascertain if existing staff can do the work, and to make sure any letting of contracts will not violate contractual agreements in existence. In addition to the other mentioned criterion for contracting work a meaningful "make or buy" analysis should be developed to determine the economic benefits to be gained.

VIII. Training Hourly Maintenance Personnel

SCOPE

In many highly mechanized plants, the margins of profit and loss are, to a considerable extent, determined by the quality and effectiveness of maintenance. The dependability and availability of complex equipment are a function of how well the maintenance operations are performed. To ensure the continued effectiveness of maintenance in modern plants, whatever the size, the training of maintenance personnel is essential.

The following tables present the percentage of companies participating in the survey who use apprentice programs and the length of these programs when employed. Three additional categories were added in the 1972 survey to provide a better insight to program durations.

DATA

INDUSTRY	Total Firms	No. of Firms Responding	NO PROGRAM		1 YR.		2 YR.		3 YR.		4 YR.		5 YR.		COMBINATION	
			% of Response	No. Firms	% of Response	No. Firms	% of Response	No. Firms	% of Response	No. Firms	% of Response	No. Firms	% of Response	No. Firms	% of Response	No. Firms
Fabricated Metal Products	110	107	69	74	2	2	7	7	4	4	18	19	–	–	1	1
Chemical and Allied Products	93	92	47	43	2	2	9	8	12	11	26	24	2	2	2	2
Food and Kindred Products	55	52	48	25	4	2	6	3	10	5	29	15	–	–	4	2
Paper and Allied Products	41	40	30	12	8	3	3	1	8	3	40	16	5	2	8	3
Electrical Equipment	36	35	74	26	3	1	3	1	3	1	14	5	–	–	3	1
Primary Metal	34	33	42	14	3	1	9	3	9	3	33	11	–	–	3	1
Rubber and Plastics	33	32	56	18	9	3	6	2	3	1	19	6	–	–	6	2
Stone, Clay, Glass	25	25	52	13	4	1	4	1	12	3	20	5	–	–	8	2
Machinery Nonelectrical	23	23	83	19	–	–	4	1	–	–	13	3	–	–	–	–
Transportation	21	20	65	13	–	–	10	2	–	–	15	3	–	–	10	2
Total – All Industries	471	459		257		15		29		31		107		4		16
Average – All Industries			56		3		6		7		23		1		3	
Ranking Position			1		5		4		3		2		6		5	

INDUSTRIAL GROUP	Total Firms	No. of Firms Responding	NO PROGRAM		1 YR.		2 YR.		3 YR.		4 YR.		5 YR.		COMBINATION	
			% of Response	No. Firms	% of Response	No. Firms	% of Response	No. Firms	% of Response	No. Firms	% of Response	No. Firms	% of Response	No. Firms	% of Response	No. Firms
Heavy Fabricating	99	97	71	69	1	1	5	5	2	2	15	15	1	1	4	4
Light Fabricating	151	144	69	99	1	2	6	8	3	5	17	25	1	2	2	3
Heavy Process	229	224	46	102	4	10	7	15	9	21	28	62	2	4	4	10
Light Process	68	65	53	35	5	3	6	4	8	5	25	16	–	–	3	2
Services	54	54	65	35	5	3	2	1	2	1	11	6	–	–	15	8
Miscellaneous	22	22	59	13	–	–	–	–	–	–	23	5	5	1	13	3
Total – All Groups	623	606		353		19		33		34		129		8		30
Average – All Groups			58		3		5		6		21		1		5	
Ranking Position			1		5		4		3		2		6		4	

ANALYSIS

As indicated in the 1969 survey, most reporting companies do not have an effective apprentice training program. This may be due to the availability of skilled craftsmen on the labor market, or perhaps as an economic necessity to avoid the cost of training.

A slight decrease (61% to 58%) is shown for participating companies in 1972, who do not have a maintenance apprentice program. The Paper and Allied Products and Primary Metal industries are the only two significant changes in the "No Program" category. While Paper and Allied Products decreased 11 percentage points, Primary Metal industries increased 13 percentage points in an average offsetting result.

Apparently participating companies with apprentice programs tend to favor a four-year program as shown in both surveys. The program duration appears to be related to the functional requirement of maintenance personnel to maintain varying degrees of complex equipment in the different industries.

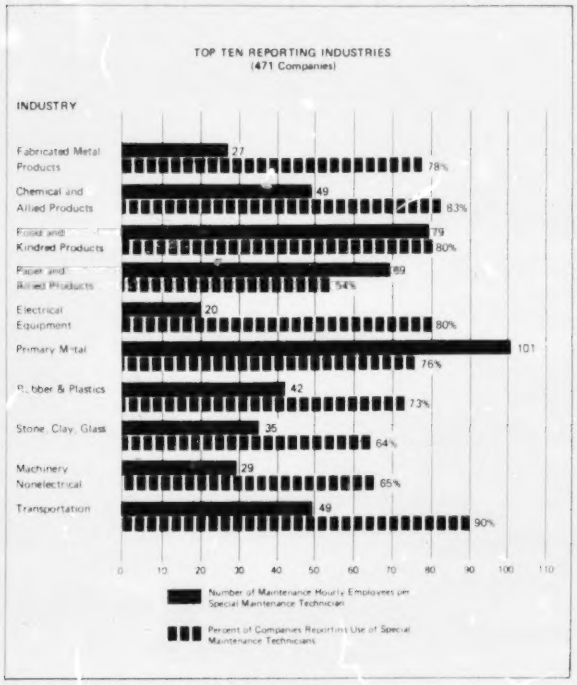
IX. Special Maintenance Technician Requirements

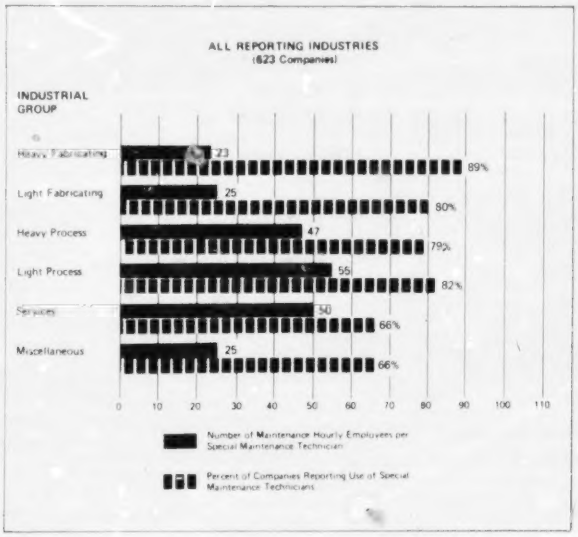
SCOPE

The sophistication of modern automated equipment demands an equal technical sophistication of maintenance personnel. In-line machines with advanced control and sensing devices permit long series of interdependent operations and also allow for more stringent operating tolerance capabilities. Downtime for this type of operation becomes extremely costly.

The following graphs present the percentage of reporting companies that use special technicians in maintenance and the ratio of maintenance hourly employees to special technicians when they are used. Special maintenance technicians are defined as those employees requiring special skills such as numerical control technicians, vibration analysis technicians, electronic maintenance technicians and numeric control electricians.

DATA





ANALYSIS

Special maintenance technician use is apparently on the increase with an overall change from 55% in 1969 to 79% in 1972 as reported by the participating companies. In addition, the ratio of maintenance hourly employees per special technician has increased from 33:1 in 1969 to 37:1 in the current survey. This survey does not reflect any differences in requirements for special technical skills. It is noteworthy that the lowest percent of the industry groups using special technicians in 1969 was 49% and in 1972 the lowest is 66%. Within the top ten industries the lowest percentage using these special skilled employees was 32% in 1969 and the lowest in 1972 is 54%. This fact seems to further substantiate the growing use of maintenance technicians.

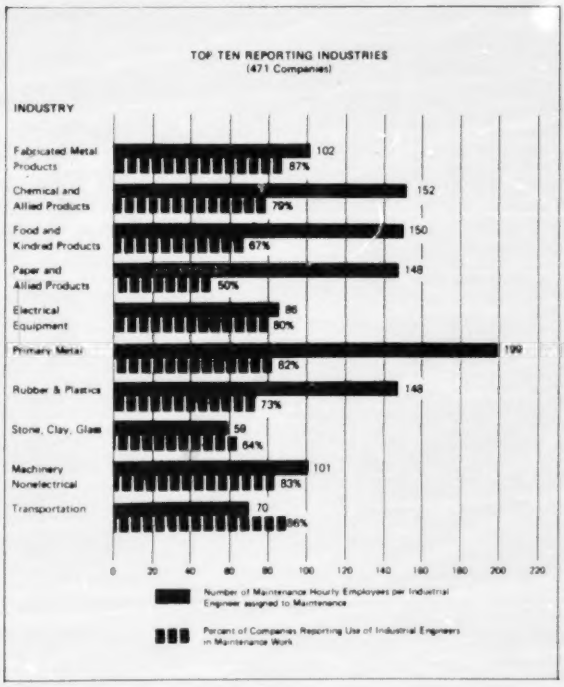
X. Industrial Engineers in Maintenance

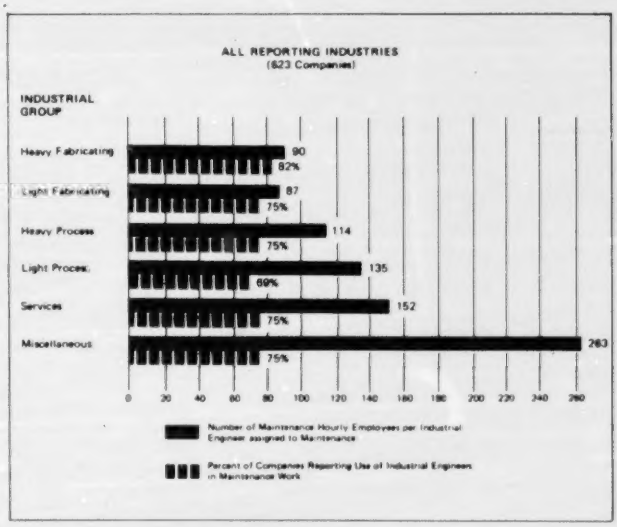
SCOPE

During the past relatively recent years, automation, greater mechanization and rising labor and material costs have increased maintenance costs generally to the point where control is vital if companies are to stay in business. Industrial engineering principles and techniques, well proven in the production area, if properly applied, can greatly aid management in establishing this control. Methods improvement, work simplification, work measurement and cost control programs can substantially improve maintenance operations.

The following graphs present the percent of companies by industries that have industrial engineers assigned to maintenance and the ratio of maintenance hourly employees to industrial engineers where used. Industrial engineers are defined as employees required to maintain and administer methods, procedures and measurement programs associated with maintenance.

DATA





ANALYSIS

This current survey shows a substantial increase (40% in 1969 survey to 76% in 1972 survey) in the number of participating companies that reported industrial engineers assigned to maintenance. Although more firms are using industrial engineers, the overall ratio of maintenance employees per industrial engineer was increased from 67:1 to 113:1. Apparently the number of assigned industrial engineers are being held to a minimum and/or constant level to meet specific requirements of the various participating companies in those companies utilizing I.E.'s in maintenance. There are substantial variations among the industries for both frequency and use of the number of industrial engineers per maintenance hourly employee. The unanimous and significant increase of the maintenance employee ratio to assigned industrial engineers, as compared to the ratio of I.E.'s to production personnel, indicates management does not practice the same degree control of maintenance operations as production. It has been our experience that the number of hourly employees an industrial engineer can effectively administer depends on the availability of support personnel such as planners, estimators, and standards applicators and access to electronic data processing equipment. The better the support, the larger the number of maintenance employees that can be handled by an industrial engineer.

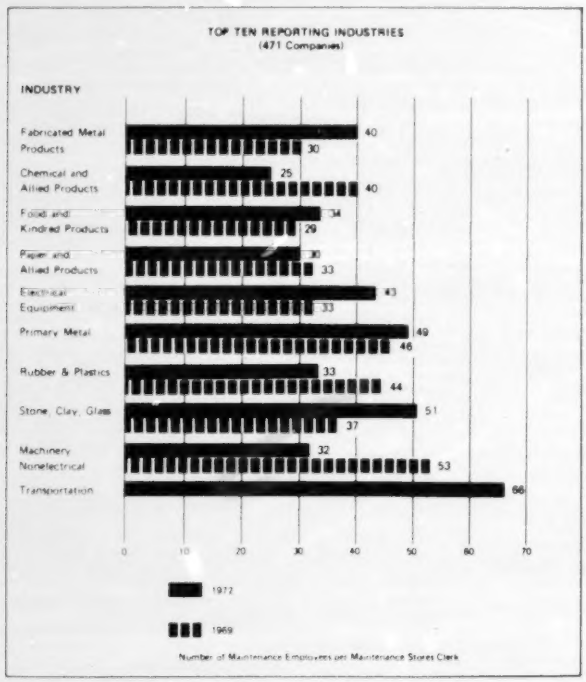
XI. Maintenance Storekeeping Requirements

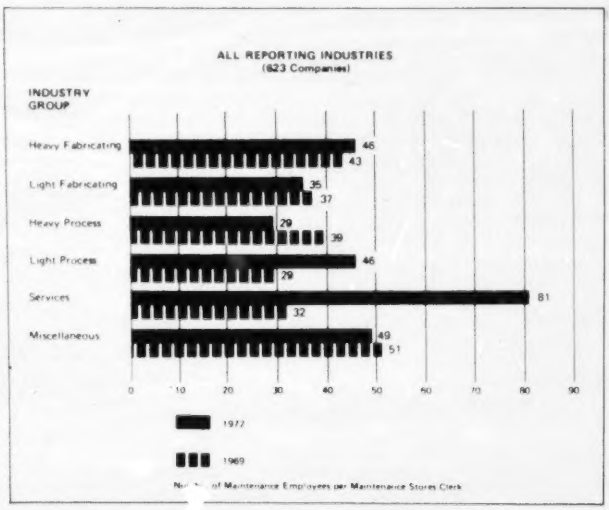
SCOPE

The proper control of maintenance spare parts, materials and supplies is an important factor in reducing maintenance costs to a minimum. In many plants there is a tendency to underestimate the importance of proper control in this area. Few people realize how often mechanics must go to the storeroom and how much this costs. A review of work orders would undoubtedly reveal that 80% to 85% of all maintenance jobs take less than two hours. Most of these jobs require at least one trip to the storeroom.

The following graphs present the average ratios, by industry, of the number of maintenance hourly employees per stores employee.

DATA





ANALYSIS

The average ratio of maintenance hourly employees per storeroom clerk remained at 38:1 for this survey, the same as the 1969 ratio. In the industry groups three ratios decreased while the other three apparently had a compensating increase in their ratios. Within the nine industries carried into the top ten industries of this survey, four industries show a decrease and five show an increase in their ratios. The significant variations among the industries (25:1 for the Chemical to 66:1 for the Transportation industries) may be attributed, at least in part, to the degree of electronic data processing equipment utilization for inventory control, record keeping and other routine clerical tasks that are performed by storeroom clerks. For an individual company, many other factors affect the number of stores clerks that are necessary. Companies will require comparatively more stores personnel if the practice is for clerks to deliver materials/tools to jobs; clean, paint and make minor repairs to hand tools; perform warehouse duties, etc.

There must be an adequate number of stores personnel to maintain stockroom integrity, keep stock levels to proper limits, process paperwork, place material in its proper place, etc. Some firms reduce their stockroom personnel by utilizing these persons on the first shift, while leaving the stockroom open and unmanned in the second and third shifts, a practice which cannot be condoned.

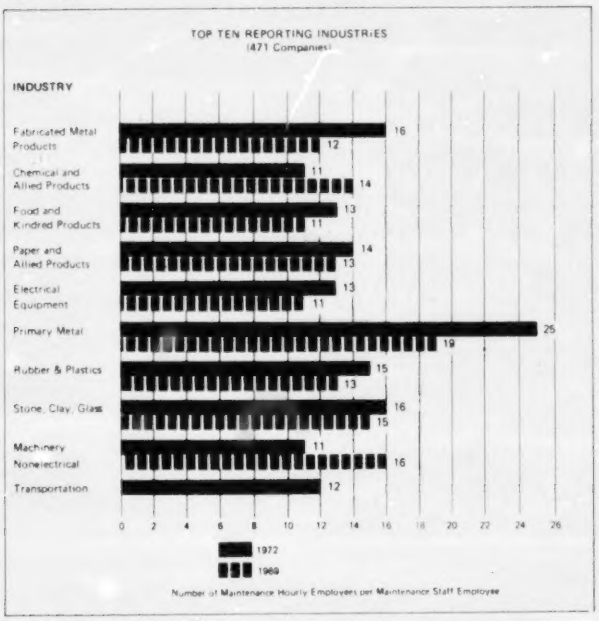
XII. Maintenance Total Staff Manpower

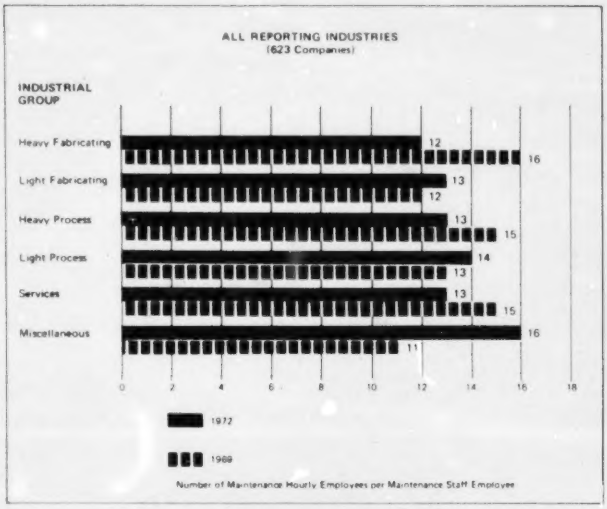
SCOPE

Management's experience with production control has proven that best results are obtained when work input controls and work performance controls are kept separate. The application of this concept to maintenance operations has, however, been a relatively recent development. Staff specialists in maintenance are increasingly being used to perform planning, conduct methods improvement programs, establish and administer work measurement programs and provide general advisory services to line management. As the economic advantage becomes more apparent, there will be a corresponding increase in the staff support available for maintenance operations.

The following graphs present the average ratios, by industry, of the number of maintenance hourly employees per maintenance staff employee. Included as maintenance staff are planners, clerks, stores personnel and industrial engineers assigned to maintenance.

DATA





ANALYSIS

The average ratio of maintenance hourly employees per maintenance staff employee is 13:1 for 1972, compared to 14:1 for 1969 for all the companies surveyed. Expressed differently, maintenance staff personnel represent 8% of the total maintenance hourly work force. The ratio varies by industry, ranging from 11:1 Machinery Nonelectrical and Chemical and Allied Products to 25:1 in Primary Metal.

There have been offsetting shifts in staff to hourly employee ratios from those indicated in the last survey. This has been within both industry and industrial group. The percentage of staff people within the total maintenance work force has risen from 7% in 1969 to 8% in the current survey.

It is apparent from the data that the maintenance manager receives less staff support than his counterpart in production, where a ratio of direct hourly to staff employees of 7:1 is not uncommon. Of equal importance is the composition of the maintenance staff force compared to production staff. There are typically fewer control staff employees, such as planners and industrial engineers in the maintenance staff force compared to production staffs. It is the input control employees that contribute the most in improving the efficiency of direct labor utilization. While the current survey represents a gain over the 1969 survey, there remains a considerable improvement to be made by the proper assignment and use of input control employees.

XIII. Measuring Maintenance Work

SCOPE

Many techniques for measuring and controlling maintenance activities are presently available to management. There is, however, a considerable variation in the accuracy achieved by the various techniques ranging from rough historical data tabulated from existing records to detailed work standards based on engineered standard data. Any company, when selecting a particular technique, must examine the nature of its maintenance work, the information available about the work, and the end use or purpose of the measurement system.

The cost benefits achieved by implementing a well-designed, effective maintenance work measurement program can be quite dramatic. In companies without a measurement and control program, maintenance labor performance is generally found to be 50% to 60% of a Fair Day's Work Level – sometimes even less. The implementation of an effective measurement program without incentives often boosts this performance up to 75% to 80%. In terms of manpower, this means accomplishing the same amount of work with one-fifth to one-third fewer employees, thus achieving a dramatic cost reduction.

The following tables show the type of measurement presently being used by the companies responding to the survey. Many companies reported use of several techniques and as a result percentages will not necessarily add to 100%.

DATA

INDUSTRY	Total Firms	No. of Firms Responding	% Response of Total	EST.		SLOT'G.		WORK SAMP.		HIST.		STDS.		OTHER	
				% of Response	No. Firms	% of Response	No. Firms	% of Response	No. Firms	% of Response	No. Firms	% of Response	No. Firms	% of Response	No. Firms
Fabricated Metal Products	110	100	91	81	81	3	3	9	9	52	52	10	10	6	6
Chemical and Allied Products	93	85	91	82	70	2	2	27	23	62	53	18	15	2	2
Food and Kindred Products	55	53	96	91	48	—	—	13	7	51	27	13	7	2	1
Paper and Allied Products	41	39	95	77	30	—	—	5	2	49	19	28	11	8	3
Electrical Equipment	36	35	97	86	30	6	2	20	7	46	16	34	12	3	1
Primary Metal	34	33	97	82	27	3	1	6	2	61	20	12	4	6	2
Rubber and Plastics	33	31	94	80	25	3	1	23	7	65	20	6	2	—	—
Stone, Clay, Glass	25	23	92	91	21	9	2	9	2	57	13	9	2	4	1
Machinery Non-electrical	23	20	87	80	16	5	1	10	2	55	11	20	4	15	3
Transportation	21	21	100	95	20	10	2	10	2	52	11	29	6	5	1
Total – All Industries	471	440			368		14		63		242		73		20
Average – All Industries			93	84		3		14		55		17		5	
Ranking Position				1		6		4		2		3		5	

INDUSTRIAL GROUP	Total Firms	No. of Firms Responding	% Response of Total	EST.		SLOT'G.		WORK SAMP.		HIST.		STDS.		OTHER	
				% of Response	No. Firms	% of Response	No. Firms	% of Response	No. Firms	% of Response	No. Firms	% of Response	No. Firms	% of Response	No. Firms
Heavy Fabricating	99	94	95	86	81	6	6	15	14	50	47	30	28	5	5
Light Fabricating	151	139	92	82	115	9	12	12	16	55	76	15	21	6	9
Heavy Process	229	214	93	82	176	3	6	17	36	59	127	16	34	4	8
Light Process	68	65	96	91	59	—	—	14	9	49	32	15	10	3	2
Services	54	54	100	76	41	7	4	24	13	41	22	33	18	11	6
Miscellaneous	22	22	100	91	20	5	1	13	3	59	13	31	7	9	2
Total – All Groups	623	588			492		29		91		317		118		32
Average – All Groups			94	84		5		15		54		20		5	
Ranking Position				1		5		4		2		3		5	

ANALYSIS

This survey included the category of historical data as a means of measuring maintenance and it ended up second as the most used means of measurement. Again the overwhelming majority of reporting companies rely on job estimates (84%) but the magnitude of companies relying on historical data (54%) is significant. Historical data is usually more simply and economically obtained versus estimates or other means of measurement. However, the results in work performance improvement obtained from estimates are generally less than improvements based on measurement. Estimates and historical data have the inherent weakness of inconsistency and reflect existing levels rather than attainable levels of performance.

XIV. Facility/Equipment Value Maintained

SCOPE

The prime objective of the maintenance group is the conservation of plant facilities, machinery and equipment at the lowest possible cost. In the charts below we will present the industry groups, a range of facility and equipment values and the number of respondents within each range who are currently charged with maintaining the facilities and equipment.

DATA

INDUSTRY	Total Firms	No. of Firms Responding	% Response of Total	UP TO $5MM		$5 to $25 MM		$25 to $100 MM		Over $100 MM	
				% of Response	No. Firms	% of Response	No. Firms	% of Response	No. Firms	% of Response	No. Firms
Fabricated Metal Products	110	108	99	29	31	42	45	25	27	4	5
Chemical and Allied Products	93	90	97	16	14	36	33	32	29	16	14
Food and Kindred Products	55	53	97	30	16	30	16	28	15	12	6
Paper and Allied Products	41	41	100	15	6	27	11	51	21	7	3
Electrical Equipment	36	36	100	33	12	25	9	33	12	9	3
Primary Metal	34	34	100	18	6	26	9	30	10	26	9
Rubber and Plastics	33	32	97	28	9	35	11	28	9	9	3
Stone, Clay, Glass	25	24	96	25	6	33	8	33	8	9	2
Machinery Nonelectrical	23	23	100	18	4	30	7	48	11	4	1
Transportation	21	21	100	19	4	33	7	33	7	15	3
Total – All Industries	471	462			108		156		149		49
Average – All Industries			98	23		34		32		11	
Ranking Position				3		1		2		4	

INDUSTRIAL GROUP	Total Firms	No. of Firms Responding	% Response of Total	UP TO $5MM		$5 to $25 MM		$25 to $100 MM		Over $100 MM	
				% of Response	No. Firms	% of Response	No. Firms	% of Response	No. Firms	% of Response	No. Firms
Heavy Fabricating	99	97	98	25	24	26	25	39	38	10	10
Light Fabricating	151	149	99	22	33	46	68	26	39	6	9
Heavy Process	229	224	98	18	41	32	72	35	78	15	33
Light Process	68	66	97	27	18	37	24	27	18	9	6
Services	54	54	100	15	8	30	16	37	20	18	10
Miscellaneous	22	22	100	45	10	23	5	14	3	18	4
Total – All Groups	623	612			134		210		196		72
Average – All Groups			98	22		34		32		12	
Ranking Position				3		1		2		4	

ANALYSIS

Analyzing the ranges of value that our respondents are charged with maintaining and conserving, it must be realized that the maintenance group is responsible for safeguarding massive amounts of capital. This is especially true in the "capital intensive" industries. The abuse of facility and equipment by improper or total lack of maintenance is not as abrupt or spectacular as abuse or loss by fire or theft; but, in some ways it is worse because of the fact that no insurance is in effect to guard against this type of loss.

When we think of the four value ranges used here: Up to $5 MM, $5 to $25 MM, $25 to $100 MM, and over $100 MM, there may be lack of reporting uniformity in that the numbers expressed may be the actual value of the asset, or replacement cost or actual minus depreciation or some other valuation methods devised by accounting practitioners. It can be concluded, however, that in an inflationary economy such as ours, the replacement cost of assets is much greater than their actual book value.

It is logical to assume that the longer the maintenance group can keep equipment and machinery in good functional order past the time when it has reached zero book value, the more they will have contributed to the profitable operation of the business.

To assist the maintenance group in achieving their objective, many firms have implemented scientific management techniques. Some of these are: a form of planning, such as preventive maintenance; lubrication classifications and scheduling; planning and scheduling of maintenance tasks; monitoring of life-to-date maintenance costs, and many other innovative techniques.

XV. EDP Use in Maintenance

SCOPE

As is commonly known, Electronic Data Processing (EDP) is the phrase used to designate the processing of data electronically by computers. It is particularly useful where voluminous amounts of data must be sifted and collated into a well-organized, highly usable document, available in minimum time from date of occurrence.

Data processing has many advantages over manual processing of data, such as speed, accuracy and data recall. It is highly unlikely that the maintenance requirements of an organization alone could justify the advent of a computer. There are other avenues to EDP assistance which would circumvent an in-house computer such as: time sharing terminals, computer service bureaus or merely obtaining a hook-up into the corporation's central data processing center. Any of these could be the avenue of access for the maintenance group to obtain the use of EDP technology.

The respondents were grouped in five classes which were: not used, payroll, planning and scheduling of maintenance, part/supply inventory and job cost/budget control.

DATA

INDUSTRY	Total Firms	No. of Firms Responding	% Response of Total	NOT USED		PAYROLL		PLAN./SCHED. MAINT.		PARTS/SUPPLY INVEN.		JOB COST/BUD. CONTROL		OTHER	
				% of Response	No. Firms	% of Response	No. Firms	% of Response	No. Firms	% of Response	No. Firms	% of Response	No. Firms	% of Response	No. Firms
Fabricated Metal Products	110	110	100	23	25	64	70	13	14	25	28	45	49	11	12
Chemical and Allied Products	93	92	99	26	24	61	56	17	16	40	37	57	52	12	11
Food and Kindred Products	55	54	98	30	16	65	35	7	4	20	11	37	20	2	1
Paper and Allied Products	41	41	100	22	9	66	27	22	9	44	18	61	25	7	3
Electrical Equipment	36	36	100	19	7	69	25	17	6	39	14	47	17	14	5
Primary Metal	34	34	100	26	9	59	20	18	6	41	14	53	18	9	3
Rubber and Plastics	33	32	97	31	10	63	20	16	5	31	10	47	15	9	3
Stone, Clay, Glass	25	25	100	8	2	76	19	12	3	24	6	64	16	12	3
Machinery, Nonelectrical	23	22	96	18	4	64	14	27	6	27	6	55	12	18	4
Transportation	21	21	100	10	2	86	18	19	4	38	8	33	7	5	1
Total – All Industries	471	467			108		304		73		152		231		46
Average – All Industries			99	23		65		16		33		49		10	
Ranking Position				4		1		5		3		2		6	

INDUSTRIAL GROUP	Total Firms	No. of Firms Responding	% Response of Total	NOT USED		PAYROLL		PLAN./SCHED. MAINT.		PARTS/SUPPLY INVEN.		JOB COST/BUD. CONTROL		OTHER	
				% of Response	No. Firms	% of Response	No. Firms	% of Response	No. Firms	% of Response	No. Firms	% of Response	No. Firms	% of Response	No. Firms
Heavy Fabricating	98	98	100	17	17	70	69	20	20	34	33	47	46	11	11
Light Fabricating	161	161	100	23	37	62	93	15	23	24	38	46	73	11	17
Heavy Process	226	227	99	24	54	66	149	18	41	38	86	57	129	10	23
Light Process	68	67	98	31	21	64	43	9	6	22	15	33	22	6	4
Services	54	54	100	26	14	65	35	17	9	26	14	40	22	11	6
Miscellaneous	22	22	100	50	11	45	10	5	1	23	5	36	8	–	–
Total – All Groups	623	619			164		399		100		191		300		67
Average – All Groups			99	25		64		16		31		48		10	
Ranking Position				4		1		5		3		2		6	

ANALYSIS

As would be expected, the largest number of respondents utilized EDP for payroll, since payroll is one of the oldest applications of EDP equipment in existence. Payroll being a series of routine, repetitive calculations with a small number of varying input factors, it is a simple matter to apply EDP.

The next area of high concentration of response is in job cost/budget control. This again is an elementary accumulation of labor and material costs to a specific job as project number. The accumulation is periodically lumped against a budgetary total and variance loss or gain is evolved.

The next area in use of EDP is the parts/supply inventory. This group is closely related to the accumulation of material costs against a particular job since the inventory is valued at cost. From an inventory management standpoint, this program also advises when a reorder point has been reached.

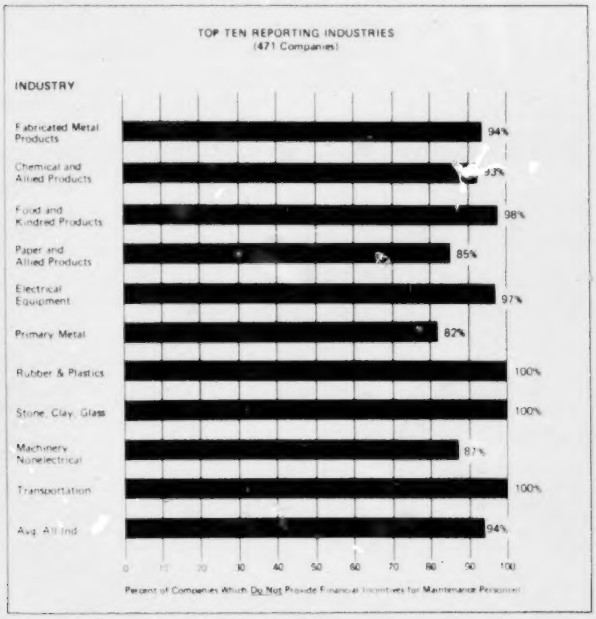
The least used area in the application of EDP is the planning/scheduling of maintenance activity. Only sixteen percent of the firms participating in the survey have EDP systems functioning in this important area. This low response is undoubtedly due to the fact that there is a lot of detailed manual work involved in installing an EDP planning/scheduling function. Quite a lot of effort is necessary in order to set the stage for computer application. As more firms embark on maintenance management improvement programs, this preliminary groundwork will be laid, and the implementation of EDP capabilities into these important and high economic return areas will be accelerated.

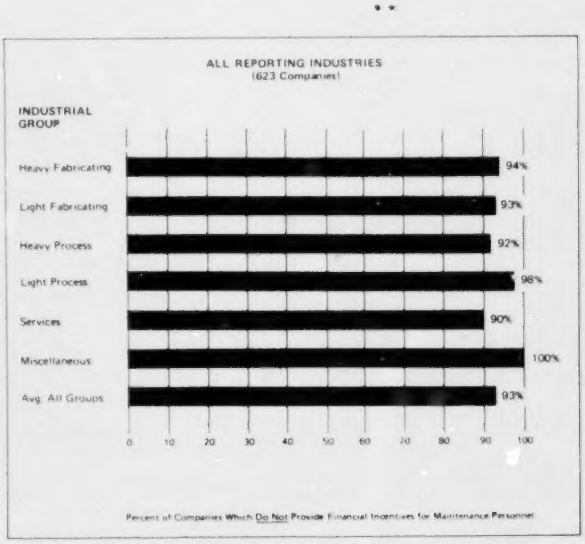
XVI. Financial Incentives for Maintenance Personnel

SCOPE

There are two bar graphs shown below representing the top ten reporting industries and all reporting industries. The graphs plot the percentage of respondents which use "no" financial incentives to motivate their maintenance personnel.

DATA





ANALYSIS

It is of notable interest that even though our respondents overwhelmingly proclaim statistically that there are few users of financial incentives, there are only three complete shutouts where no one within an industrial grouping was using financial motivation. These are Rubber and Plastics, Stone and Clay and Glass, and Transportation.

The lack of utilization of financial incentives can be explained in part by analyzing the difficulties encountered in trying to control maintenance activity. Referring to Section XIII of the survey on the Measurement of Maintenance Work we find that the majority of contributors use the techniques of historical estimates or estimating by the foremen or a former craftsman to obtain a measurement guideline. From broad experience with maintenance management applications, we have found that there is a tendency for safety cushions to slip into foremen or craftsman-generated estimates. And, estimates based upon historical data have this same factor plus other factors buried in their total.

The two measuring techniques (estimating and historical standards) which are apparently most predominantly in use lack the required discipline to make them accomplish their intended objectives. The poor success some companies have had in measuring and controlling maintenance using the above techniques would explain to a certain extent why only a small percentage of the responding firms are using financial incentives for maintenance personnel. There is a hesitancy to add to maintenance expense through the advent of financial incentives, because the system of establishing measurement guidelines is not strong enough to meet the onslaught of organized resistance and concerted effort to obtain the financial remunerations without putting forth the increased effort to earn them.

There appears to be no middle avenue. A firm either makes a commitment to a well-managed planning, scheduling and standards development function either with or without financial incentives, or failing to do this they may make certain that their supervisor's span of control is narrow enough that he is afforded time to engage in some estimating activity and close supervision to insure adherence to estimates. As another alternate, they may assign a former craftsman to estimate the work and charge the foreman with the responsibility of making the approach work.

More and more firms are considering the use of a well-engineered and properly directed maintenance incentive program based on standards as an approach to controlling their increasingly important maintenance functions. We would expect the number of companies achieving such a program to increase in the coming years.

XVII. Conclusions

While it is difficult to draw an overall conclusion based on the data contained in this survey, some generalizations may be made.

The first conclusion is that the subject of maintenance cost control is coming up in the minds of company executives more and more. This undoubtedly explains the reason why 24% more companies responded to our survey than in 1969.

Next, the overall number of maintenance employees per 1,000 production employees is increasing. Sophisticated equipment requiring greater maintenance might be one cause; another might be the fact that the average age of equipment maintained is increasing, requiring more work to keep it productive.

Supervisors seem to be directing a larger number of maintenance employees. This trend must be carefully watched, or loss of control may ensue.

In the area of input controls, it appears that a fewer number of planners per 1,000 maintenance men is being used. We question this fact, since it is good if the same planning efficacy is being achieved, and bad if less effective planning is the result.

On outside contracting, a word of caution: be sure you are taking the least cost action when you have an outside contractor. It could be that your own maintenance force could do the work cheaper if the ranks were increased to handle some continous minimum work load. Then only peak loads would be contracted out, if beyond overtime capability.

As far as training is concerned, there appears to be a need for improved training programs, whether apprentice type or other formal training, such as programed instruction. If qualified men cannot be hired, they must be "grown" by training. This is true also of the Special Maintenance Technicians.

Industrial Engineering remains yet to be used by most companies as an effective tool in reducing maintenance cost. While it has proven itself in production, still there remain many skeptics. We expect this to change with time, with more and more industrial engineering talent being assigned to maintenance.

Storekeeping is becoming a more important part of maintenance. As spares increase in value, total funds tied up in inventory tend to grow, calling for better controls and more qualified personnel.

Electronic Data Processing seems to be infrequently utilized for assistance in the control of maintenance costs. This value technique remains as a promise of better things to come for many companies in the maintenance area.

Finally, incentives for maintenance are still a more-or-less "unplowed field". While proven in manufacturing, most firms have not yet applied the concept to maintenance and reaped the cost reduction benefits of a well-engineered program.

In conclusion, it is safe to say that even in the year 2972, there will still be a vital need for effective maintenance facilities. Actions taken now prepare the way for the future. As it has been said many times, "The future belongs to those who prepare for it".

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COMPENSATION MANAGEMENT	Incentive programs and work measurement for both direct and indirect workers, comparative compensation studies, basic compensation for executive, sales, salaried, production and maintenance workers.
MAINTENANCE MANAGEMENT	Organizing plant engineering and maintenance functions: developing systems and procedures for planning, scheduling preventive and corrective maintenance and other work input controls; work sampling, standard data and incentives to control work output.
OFFICE MANAGEMENT	Clerical work control programs that enable managers to control work and staff levels through systematic work measurement and simplification, methods improvement, personnel evaluation and standards of performance.
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